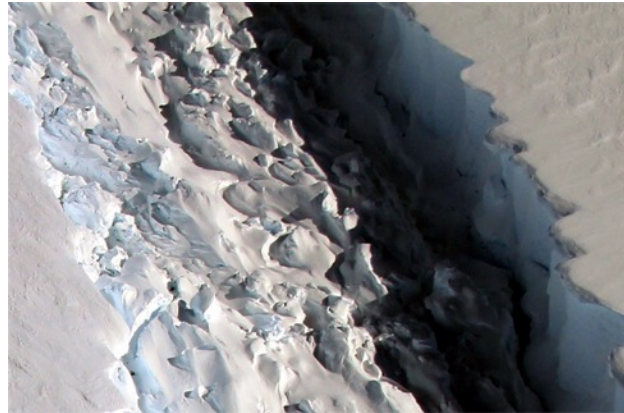


SCIENCE



Surface Biology and Geology Overview and SDS Implications

THE SURFACE BIOLOGY AND GEOLOGY DO IS DEFINED WITH CONSIDERABLE DETAIL IN THE DECADAL SURVEY



SBG has a very broad research and applications constituency:

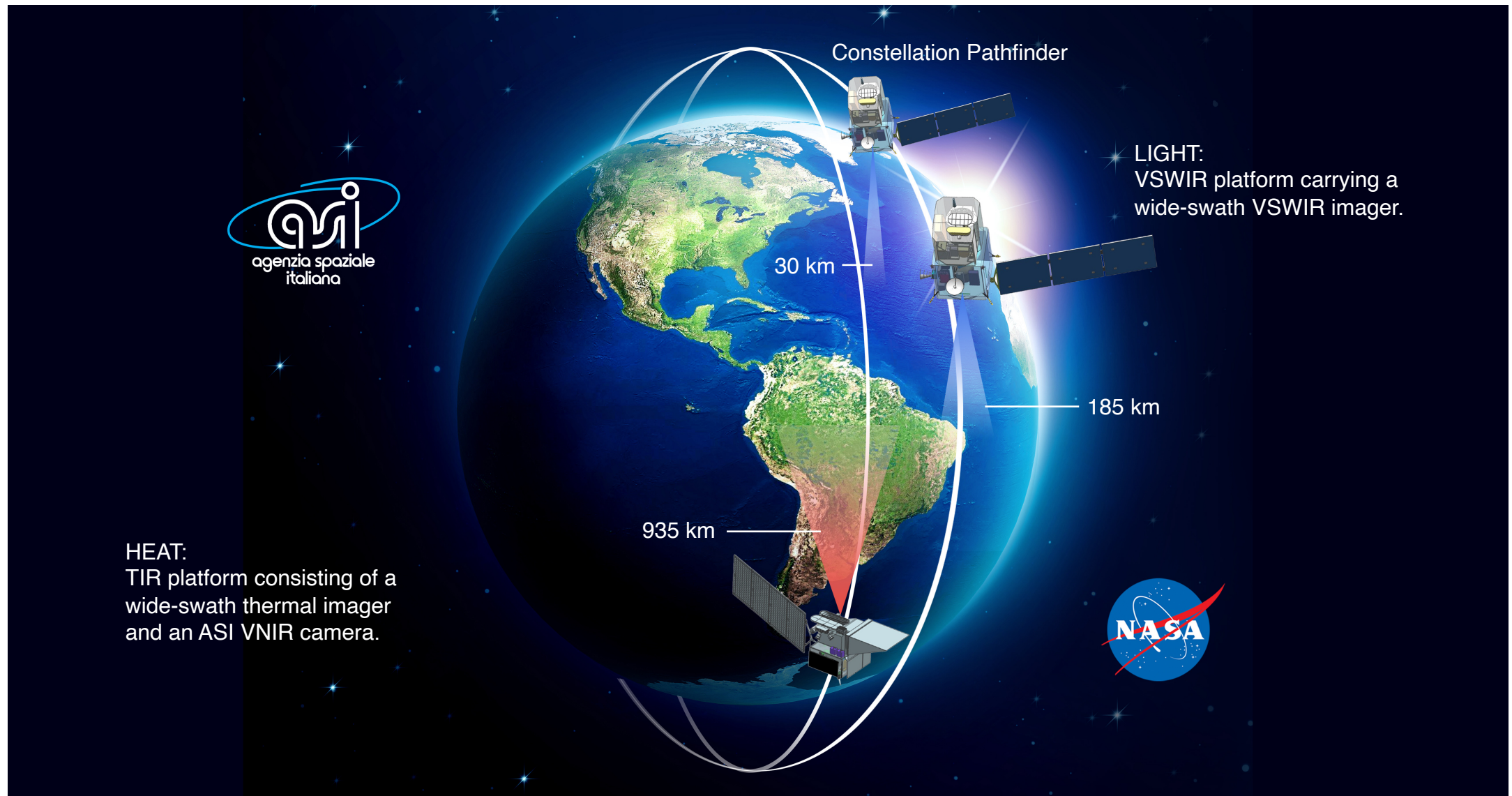
- Terrestrial and aquatic ecosystems – fire, conservation and biodiversity, agriculture and forestry
- Hydrology – snow, evapotranspiration, consumptive water use, water quality
- Weather – Surface energy balance, severe weather
- Climate – carbon-climate feedbacks, CH₄ sources and mitigation, point sources
- Solid Earth – Volcanic hazards, landslides, mineral exploration, mineland management

The Decadal Survey defines the implementation as two sensors “*Hyperspectral imagery in the visible and shortwave infrared; multi- or hyperspectral imagery in the thermal IR*”:

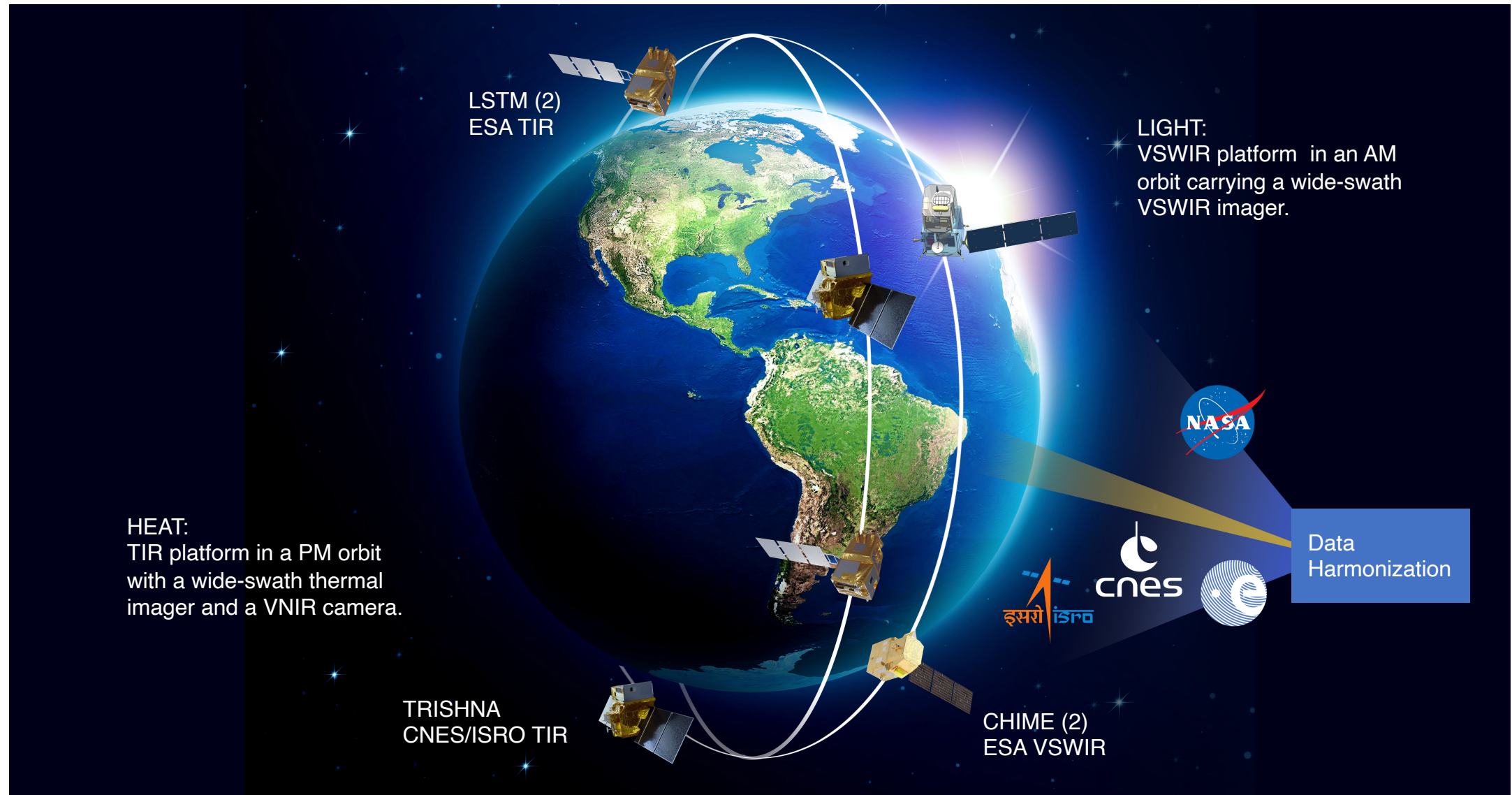
1. “....a moderate spatial resolution (30-45 m GSD), hyperspectral resolution (10 nm; 400-2500 nm), high fidelity (SNR = 400:1 VNIR/250:1 SWIR) imaging spectrometer is needed for characterizing land, inland aquatic, coastal zone, and shallow coral reef ecosystems”
2. “....30-60 m TIR observations in the 10.5-11.5 μm and 11.5-12.5 μm spectral regions are needed with a 2-4 day revisit frequency”¹

1) Note, this specification was updated based on recent work and community engagement to optimize for the DS-specified science and applications.

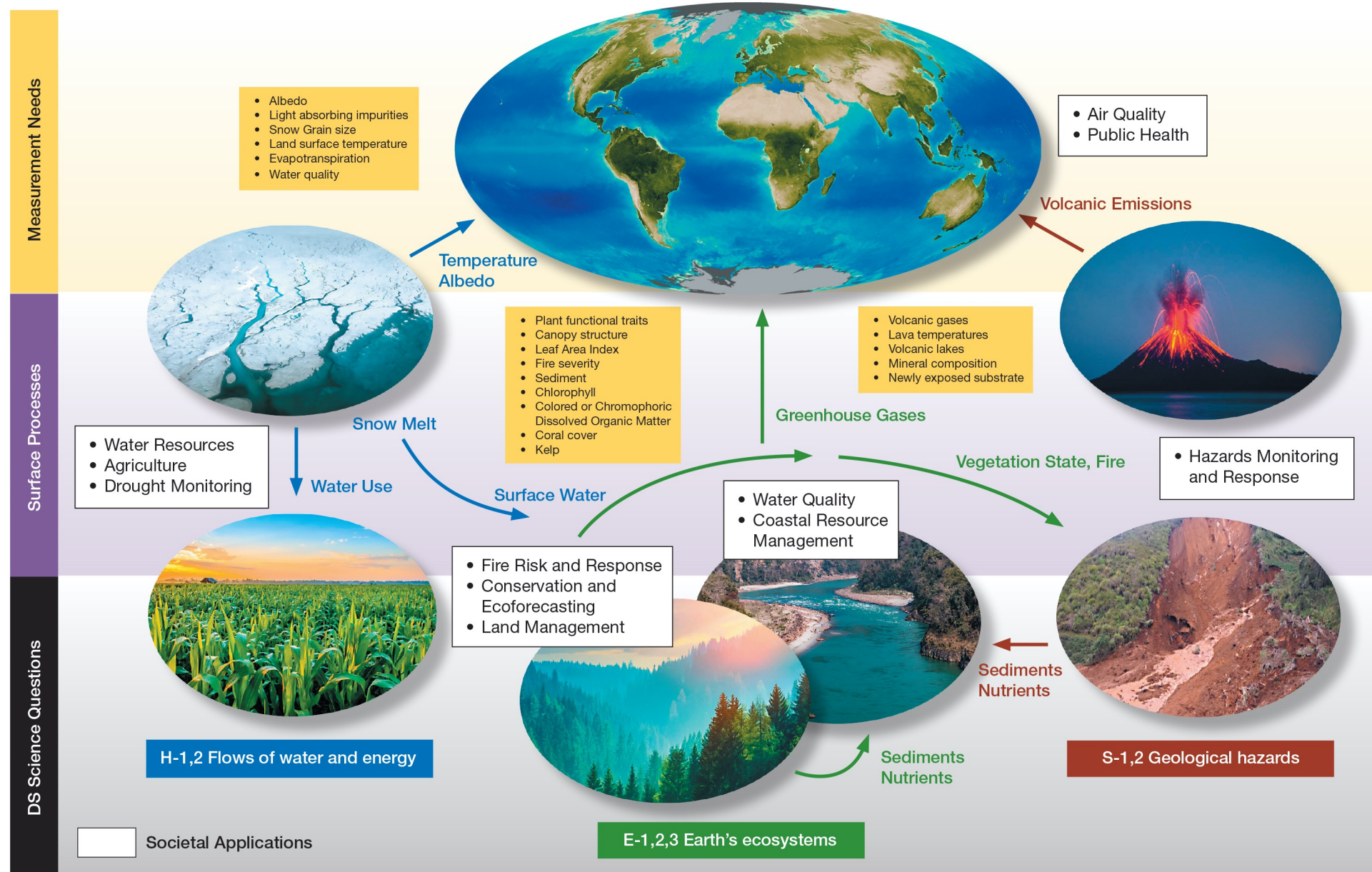
What is SBG?



SBG ESA On-Orbit Collaborations



SBG enables a wide range of data products and can support application-ready data (ARD)



SBG anticipates synergistic science and applications with with all the ESO observatories and the POR



Solid earth

Aerosols — ATMOS
Gases — SBG
Surface Deformation —
NISAR
Surface Composition
and Geologic Hazards —
SBG

Watersheds

Precipitation — ATMOS
Ice Mass Evolution —
NISAR
Snow Albedo and
Melt — SBG
Total water storage-MC

Ecosystems and agriculture

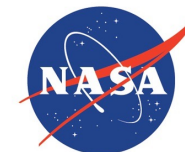
Boundary Layers —
ATMOS
Ecosystem Structure —
NISAR
Vegetation Type and
Physiology — SBG

Land-sea continuum

Phytoplankton, Organic
Matter, Sediment — SBG,
GLIMR, PACE, Boundary
layers-ATMOS

SBG'S ECOSYSTEM AND BIODIVERSITY MISSION

- E-1. Ecosystem Structure, Function, and Biodiversity. What are the structure, function, and biodiversity of Earth's ecosystems, and **how and why are they changing** in time and space?
 - E-1a. Quantify the global distribution of the functional traits, functional types, and composition of vegetation spatially and over time
 - E-1c. Quantify the physiological dynamics of terrestrial and aquatic primary producers
- E-2. Fluxes Between Ecosystems, Atmosphere, Oceans, and Solid Earth. What are the fluxes (of carbon, water, nutrients, and energy) between ecosystems and the atmosphere, the ocean, and the solid Earth, and how and why are they **changing**?
 - E-2a. Quantify the fluxes of CO₂ and CH₄ globally at spatial scales of 100-500 km and monthly temporal resolution with uncertainty < 25% between land ecosystems and atmosphere and between ocean ecosystems and atmosphere.
- E-3. Fluxes Within Ecosystems. What are the fluxes (of carbon, water, nutrients, and energy) within ecosystems, and how and why are they changing?
 - E-3a. Quantify the flows of energy, carbon, water, nutrients, and so on sustaining the life cycle of terrestrial and marine ecosystems and partitioning into functional types.



Terrestrial and Aquatic Functional Diversity

- SBG Core Data Products include functional trait estimates, and physiological properties and fluxes.
- Diversity indices can be computed from L2 reflectance (eg, spectral diversity) and from functional trait diversity.



Product Suite
Snow
Water biogeochemistry
Water biophysics
Aquatic classification
Substrate composition
Volcanic SO2 and ash
High temperature features
ET
Plant functional traits
Proportional cover



Functional Diversity captures trends in species richness...

Lamanna C, Blonder B, Violle C, Kraft NJB, Sandel B, et al. 2014.
Functional trait space and the latitudinal diversity gradient. *Proc. Natl. Acad. Sci.* 111(38):13745–50

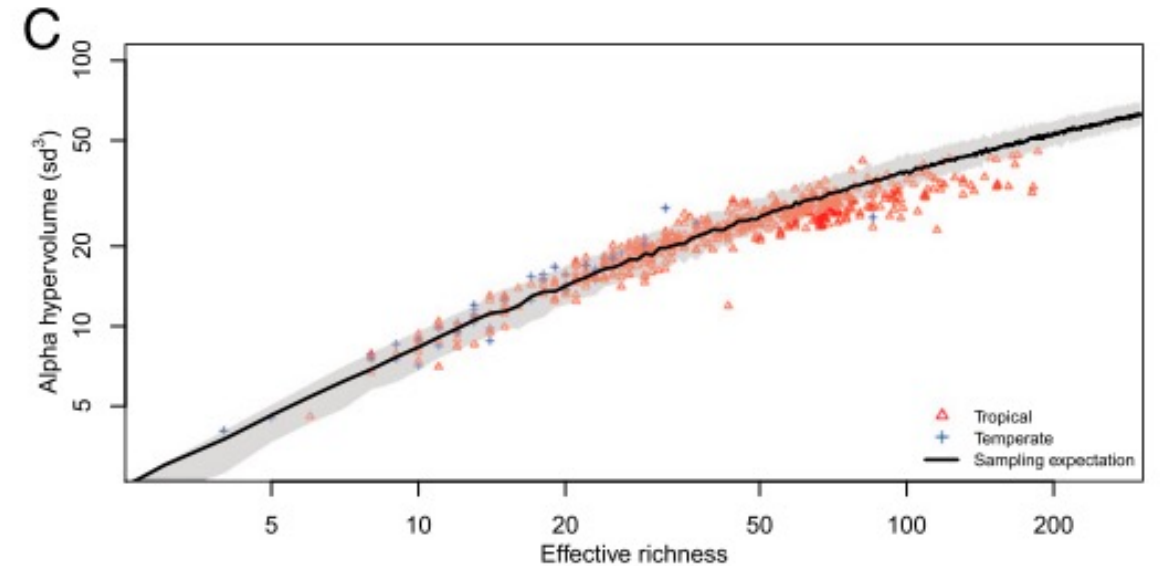
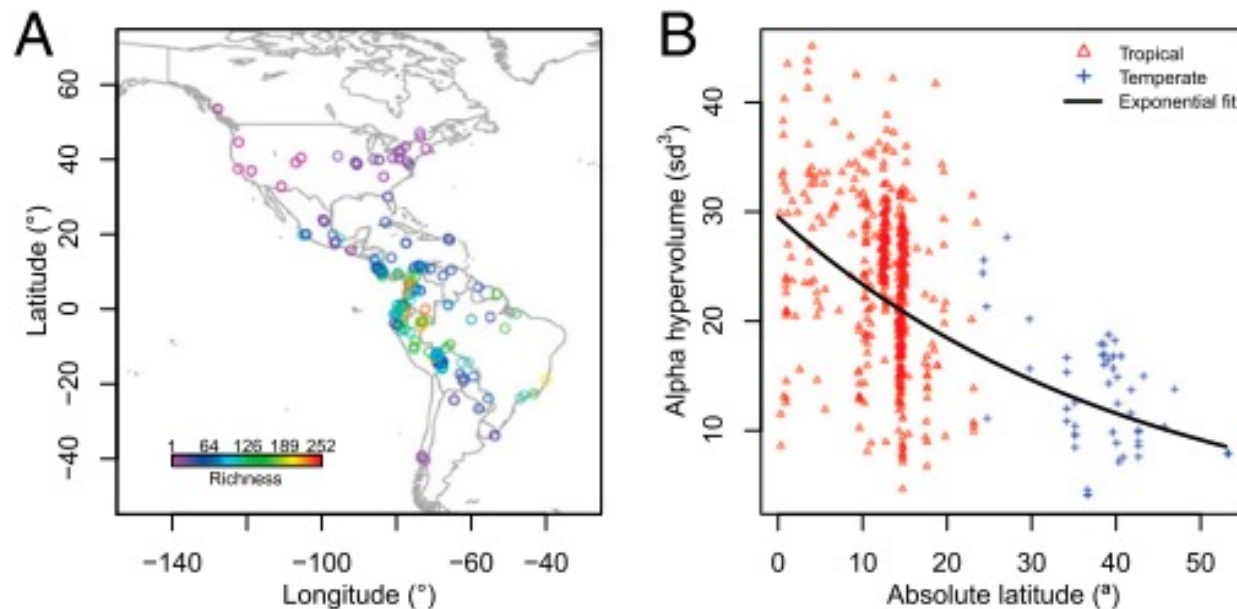
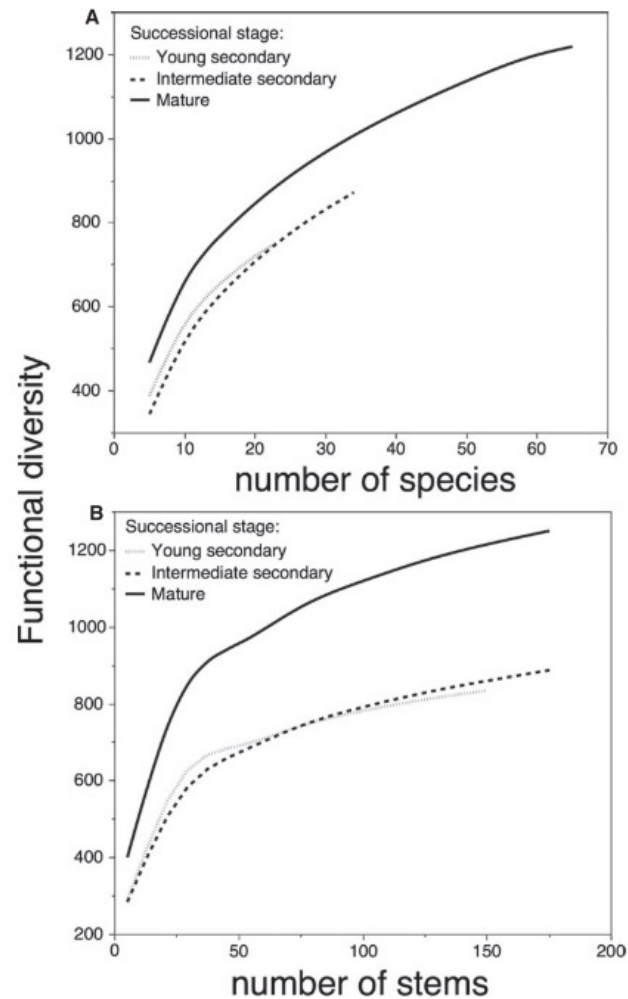


Fig. 1. (A) Spatial distribution of the 620 0.1-ha forest plots used in this study. Plots are colored by richness. Plots cover most of the New World forested climate space (Fig. S1). (B) Relationship between absolute latitude and alpha hypervolume for tropical (red triangles) and temperate (blue pluses) plots. (C) Alpha hypervolume as a function of effective species richness (number of species with full trait coverage). We compare this hypervolume with a null expectation based on sampling the same number of species from the regional pool (median, dark gray line; 90% quantile range, light gray envelope).

Mostly positive (saturating) relationships for plants/trees...



Whitfeld TJS, Lasky JR, Damas K, Sosanika G, Molem K, Montgomery R a. 2014. Species Richness, Forest Structure, and Functional Diversity During Succession in the New Guinea Lowlands. *Biotropica*. 46(5):538–48

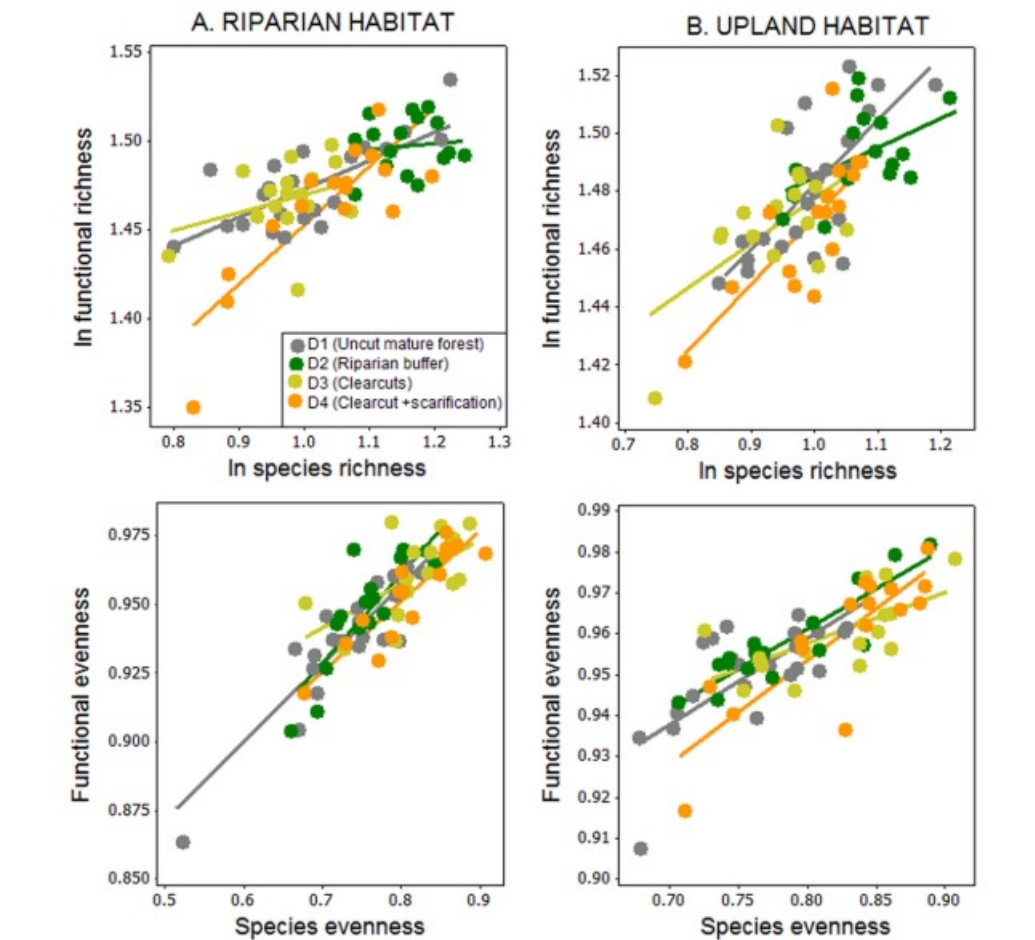
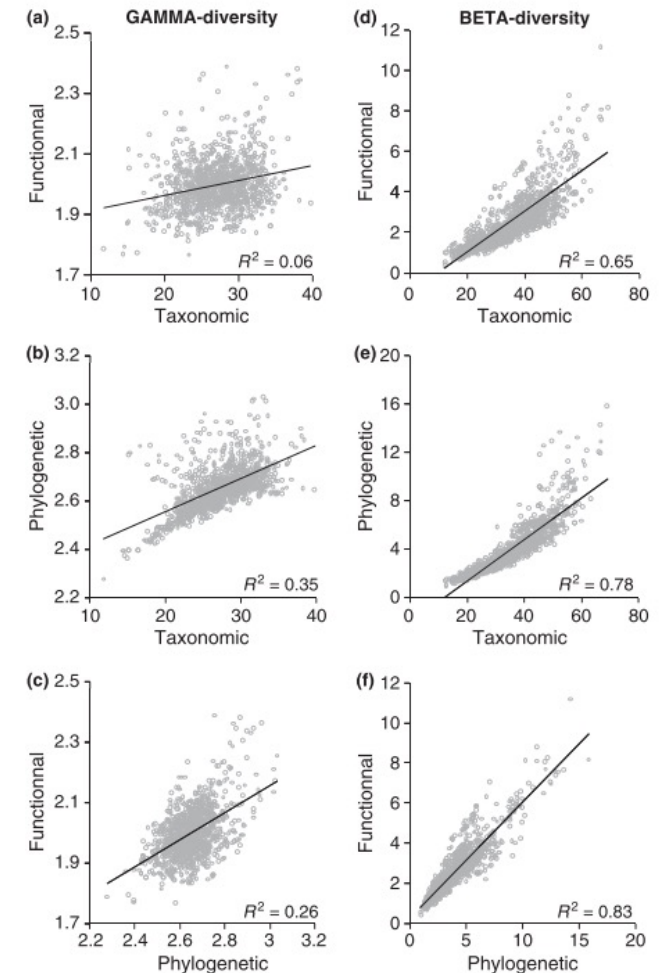


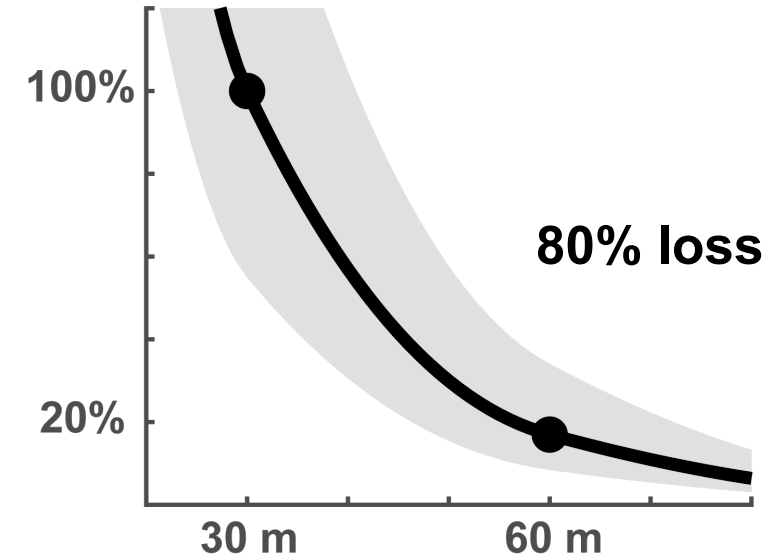
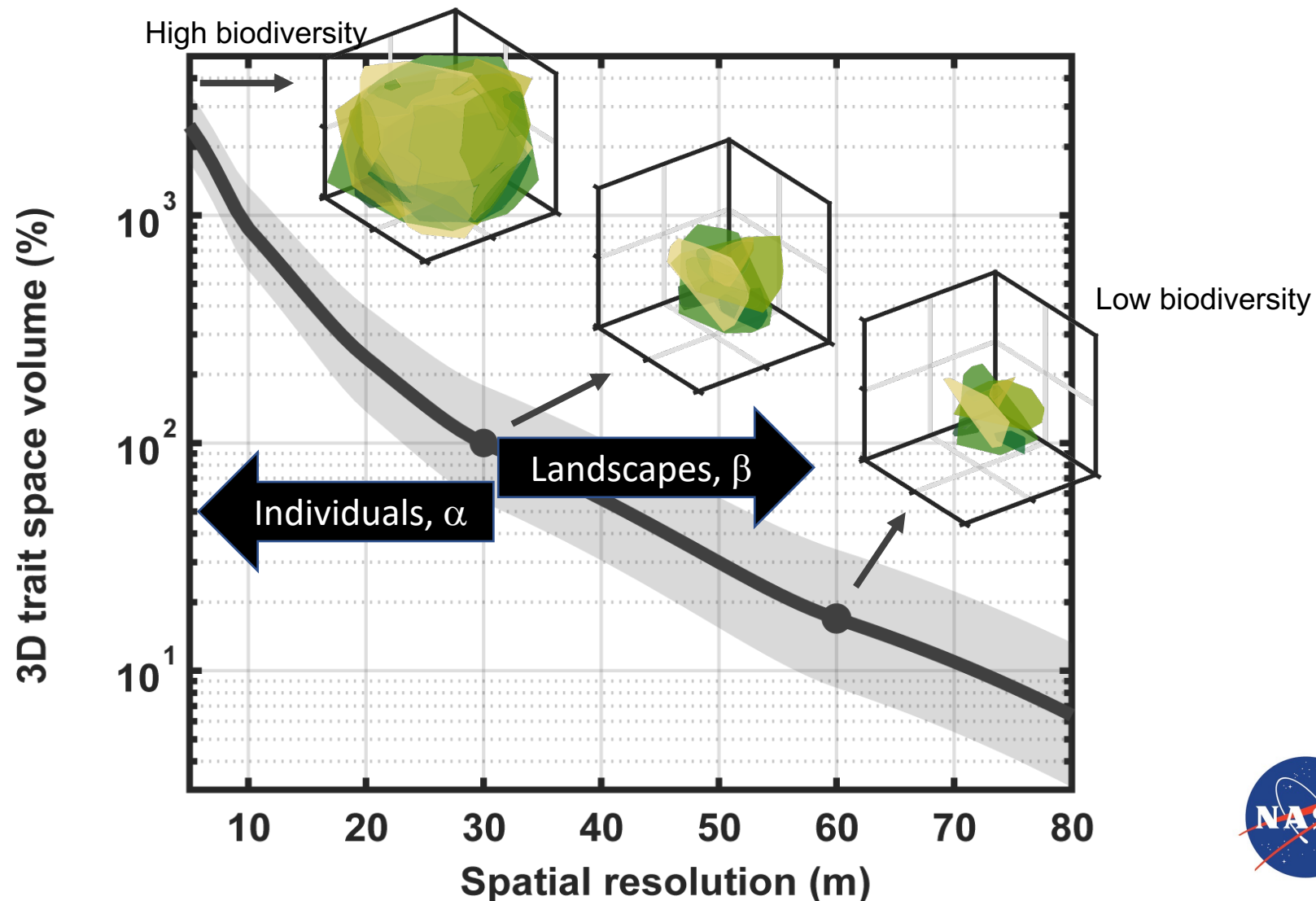
Fig. 2. Relationships between species richness and functional richness (top row), and species evenness and functional evenness (bottom row) in riparian (A) and upland (B) plant communities.

Biswas SR, Mallik AU. 2011. Species diversity and functional diversity relationship varies with disturbance intensity. *Ecosphere*. 2(4):1–10



Devictor V, Moullot D, Meynard C, Jiguet F, Thuiller W, Mouquet N. 2010. Spatial mismatch and congruence between taxonomic, phylogenetic and functional diversity: The need for integrative conservation strategies in a changing world. *Ecol. Lett.* 13(8):1030–40

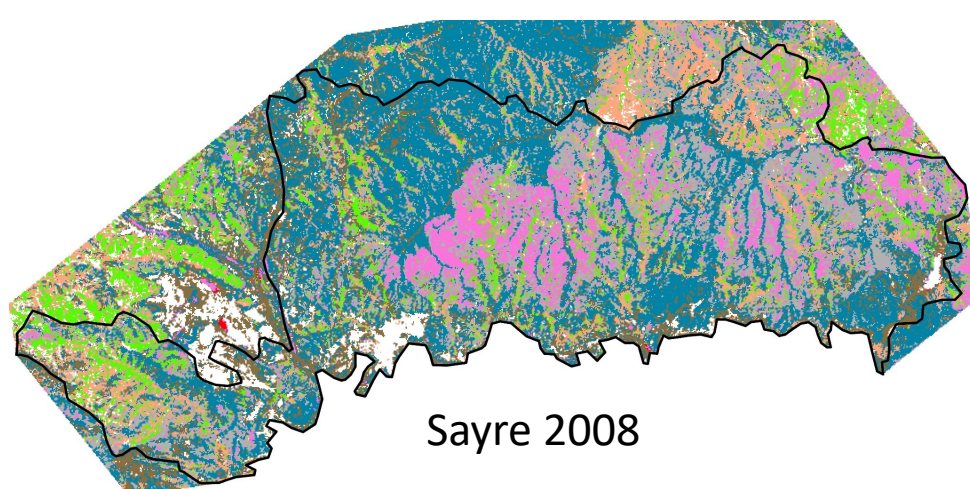
Biodiversity information depends on spatial resolution, a key mission parameter



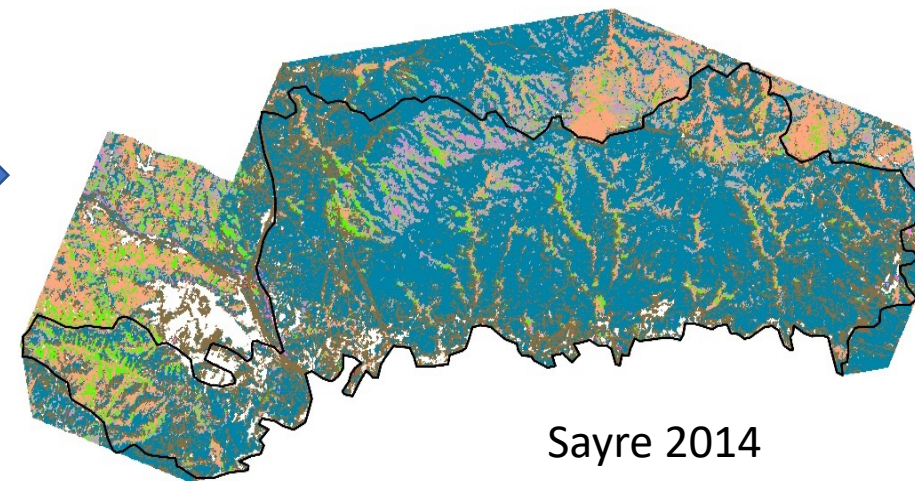
Here, the volume was derived from the orthogonal information on leaf nitrogen, leaf mass per area and leaf chlorophyll at six national ecological observatory network (NEON) sites.



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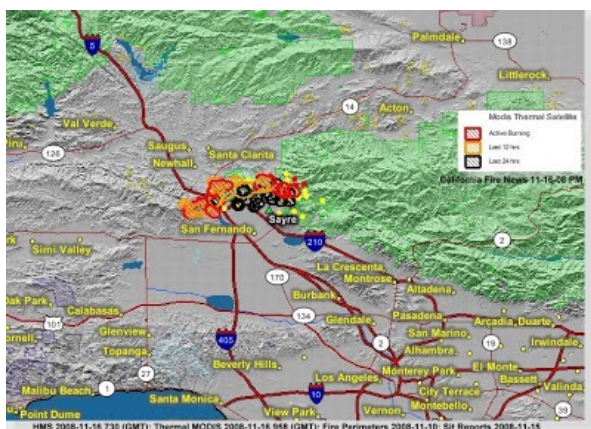
2008 Fire
Massive grass invasion



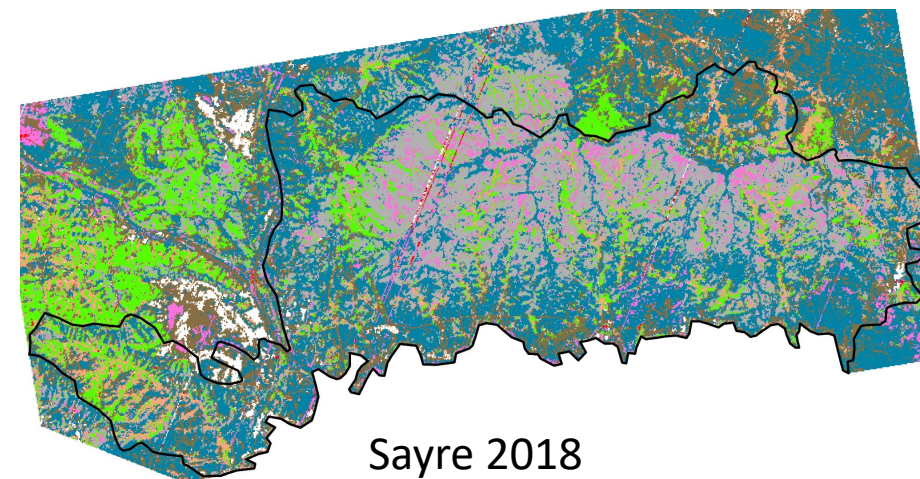
Ecosystem mapping and change detection

MESMA-Upland/Riparian trees approach

- Community 1 (Buckwheat/Blacksage/Yerba santa)
- Community 2 (Ceanothus/Manzanita/Chamise)
- Annual grass
- Riparian trees (Alder/Sycamore/Willow)
- Oak community
- Bareground
- Other



Better rain
Significant recovery



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SUMMARY

- SBG has an explicit biodiversity mission.
- SBG Core data products enable diversity studies.
- Additional diversity-related products can be computed from SBG data.
- SBG will allow understanding diversity-phenology relationships with high revisit.
- SBG spectral, spatial and revisit characteristics support regional-global biodiversity science and applications.
- SBG will provide wall-to-wall information and change over time.



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